CLAIMS:

1. An apparatus for sample analysis of samples on sample plates by atmospheric pressure matrix assisted laser desorption ionization mass spectrometry comprising:

a mass spectrometer having a vacuum chamber and an ion-sampling orifice for introduction of samples in the form of ionized products of laser desorption of said samples into said vacuum chamber of said mass spectrometer;

at least one sample plate carrier that accommodates at least one sample plate with at least one sample;

a combined moveable gripper and sample plate handling unit disconnectable from said mass spectrometer and having means for taking and releasing said at least one sample plate, means for docked interface with said ion-sampling orifice, and means for holding said at least one sample plate during introduction of said ionized products of laser desorption of said samples into said mass spectrometer.

2. The apparatus of Claim 1, further comprising:

a plurality of said sample plate carriers;

a plurality of said sample plates, each one of said sample plate carriers accommodating one of said sample plates; and a sample plate carrier storage means, wherein:

said sample plate carrier storage means has a loading position from which said sample plates are loaded into said combined gripper and sample plate handling unit;

said combined gripper and sample plate handling unit having a working position in which said ionized products of laser desorption of said samples are introduced into said mass spectrometer;

said apparatus further comprising a first module for moving said a combined gripper and sample plate handling unit between said loading position and said working position.

3. The apparatus of Claim 1, wherein said sampling orifice has a center and a longitudinal axis passing through said center and defined as Z-axis;

said first module comprising: a first Z-axis drive mechanism that supports said combined gripper and sample plate handling unit and means for moving said combined gripper and sample plate handling unit in the direction parallel to said Z-axis; and first Y-axis drive mechanism that supports said Z-axis drive mechanism and has means for moving said first Z-axis drive mechanism in a direction parallel to a Y-axis that is perpendicular to said Z-axis;

said at least one sample plate carrier comprising a guide channel for guiding said sample plates that are stacked one onto the other.

4. The apparatus of Claim 3, wherein said sample plate carrier further comprises a first stopper and a second stopper both insertable into said guide channel and operating in an alternating order so that said first stopper is moved away from said guide channel and releases one sample plate, which is located in said guide channel above said loading position, while said second stopper stops a second sample plate located in said guide channel above said one sample plate, said second sample plate being fed to said loading position by gravity.

5. The apparatus of Claim 4, wherein said combined sample plate handling unit that comprises:

gripping means for taking said sample plate from said loading position, for transporting said sample plates in said direction parallel to said Y-axis from said loading position to said working position, and for holding said sample plates in said combined sample plate handling unit during said introduction of samples into said mass spectrometer through said ion-sampling orifice;

an X-drive mechanism moveable in the direction parallel to an X-axis that is perpendicular to a plane formed by said Y-axis and Z-axis; and

a second Y-drive mechanism moveable in the direction parallel to said Y-axis.

6. The apparatus of Claim 5, wherein said gripping means comprises: at least one alignment member and wherein said sample plate carrier has at least one alignment opening for engagement with said at least alignment member; and an electromagnet, which can be energized for attracting said sample plates and de-energized for releasing said sample plates.

7. The apparatus of Claim 1, further provided with a control system that comprises a central processing units loaded with input data for controlling motions and sequence of motions performed by said combined gripper and sample plate handling unit.

8. The apparatus of Claim 6, further provided with a control system that comprises a central processing units loaded with input data for controlling motions and sequence of motions performed by said combined gripper and sample plate handling unit, said X-drive mechanism, said first Y-drive mechanism, said second Y-drive mechanism, said Z-drive mechanism, and said electromagnet.

9. The apparatus of Claim 1, wherein said sampling orifice has a center and a longitudinal axis passing through said center and defined as Z-axis;

said apparatus further comprising a first module that comprises:

a first Z-axis drive mechanism heaving means for moving in a direction of an axis parallel to said Z-axis;

a rotating stand rotatingly supported by said first Z-axis drive mechanism, said rotating stand rigidly supporting said combined gripper

and sample plate handling unit and having means for rotation together with said combined gripper and sample plate handling unit around an X-axis that is perpendicular to said Z-axis, said rotation being at least 180°.

10. The apparatus of Claim 9, wherein said at least one sample plate carrier comprising means for rotation around an axis parallel to said X-axis and having an outer periphery with a plurality of cells for positioning a plurality of said sample plates, so that during rotation of said sample plate carrier said cells are positioned one by one in alignment with said loading position.

11. The apparatus of Claim 10, wherein said combined sample plate handling unit comprises:

gripping means for taking said sample plates from said loading position, for transporting said sample plates in said direction parallel to said Z-axis from said loading position to said working position, and for holding said sample plates in said combined sample plate handling unit during said introduction of said samples into said mass spectrometer through said ion-sampling orifice;

an X-drive mechanism moveable in the direction parallel to said X-axis; and

a Y-drive mechanism moveable in the direction parallel to a Y-axis perpendicular to a plane formed by said X-axis and Z-axis.

12. The apparatus of Claim 11, wherein said gripping means is an electromagnet; said sample plate carrier further comprising sample plate holding means in each of said cells and a pushing mechanism for pushing said sample plates from said cells in said loading position towards said electromagnet when said combined sample plate handling unit is aligned with said loading position.

13. The apparatus of Claim 12, wherein said holding means is a magnet and said pushing means is a pushing rod aligned with said cells and a solenoid driving said pushing rod.

14. The apparatus of Claim 13, further comprising a central processing unit which contains input data that controls operation of said gripping means, said X-drive mechanism, said Y-drive mechanism, said Z-drive mechanism, said pushing means, said rotating stand, and said solenoid.

15. The apparatus of Claim 1, wherein said sampling orifice has a center and a longitudinal axis passing through said center and defined as Z-axis;

said first module comprising: a first Z-axis drive mechanism that supports a first X-axis drive mechanism and has means for moving said first X-axis drive mechanism in a direction parallel to said Z-axis; said first X-drive mechanism having first X-direction means and means for moving said first X-direction means in the direction parallel to an X-axis which is perpendicular to said Z-axis;

said apparatus further comprising a second module having second Z-direction means moveable in the direction parallel to said Z-axis and first Y-direction means moveable in the direction of Y-axis, which is perpendicular to said X-axis;

said combined sample plate handling unit being rigidly supported by said Y-direction means.

16. The apparatus of Claim 15, further comprising sample storage means and a sample plate carrier handling mechanism comprising first gripping means on said first X-direction means for extracting said sample plate carriers from said sample storage means.

17. The apparatus of Claim 16, wherein said combined sample plate handling unit comprises:

second gripping means for taking said sample plates from said stand-by position, for transporting said sample plates in said direction parallel to said Y-axis from said stand-by position to said center of said ion-sampling orifice, and for holding said sample plates in said combined sample plate handling unit during said introduction of samples into said mass spectrometer through said ion-sampling orifice;

second X-direction means moveable in the direction parallel to said X-axis; and

second Y-direction means moveable in the direction parallel to said Y-axis.

18. The apparatus of Claim 16, wherein said second gripping means is an electromagnet, which can be energized for gripping said sample plates and de-energized for releasing said sample plates.

19. The apparatus of Claim 15, wherein each of said sample plate carriers is provided with means for releasable engagement with said first gripping means so that said first gripping means can engage said means for releasable engagement and extract said sample plate carrier from said sample storage means.

20. The apparatus of Claim 19, wherein said means for releasable engagement comprise at least one slot having a profiled configuration and wherein said first gripping means comprise at least one projection having a configuration conforming to said profiles configuration made so that said at least one projection can be introduced into and released from said slot by moving said first gripper only in said direction parallel to said Z-axis.

21. The apparatus of Claim 17, wherein each of said sample plate carriers is provided with means for releasable engagement with said first gripping means so

that said first gripping means can engage said means for releasable engagement and extract said sample plate carrier from said sample storage means.

22. The apparatus of Claim 21, wherein said means for releasable engagement comprise at least one slot having a profiled configuration and wherein said first gripping means comprise at least one projection having a configuration conforming to said profiles configuration made so that said at least one projection can be introduced into and released from said slot by moving said first gripper only in said direction parallel to said Z-axis.

23. The apparatus of Claim 18, wherein each of said sample plate carriers is provided with means for releasable engagement with said first gripping means so that said first gripping means can engage said means for releasable engagement and extract said sample plate carrier from said sample storage means.

24. The apparatus of Claim 23, wherein said means for releasable engagement comprise at least one slot having a profiled configuration and wherein said first gripping means comprise at least one projection having a configuration conforming to said profiles configuration made so that said at least one projection can be introduced into and released from said slot by moving said first gripper only in said direction parallel to said Z-axis.

25. The apparatus of Claim 15, wherein each of said sample plate carriers is a sample plate carrier that supports a sample plate with a plurality of sample cells arranged in a predetermined order, said sample storage means comprising a cassette with a plurality of slots for supporting a plurality of said sample plate carriers, said cassette extending in said direction parallel to Z-axis and said sample plate carriers being arranged in said slots in a Y-X plane formed by said X-axis and said Y-axis.

26. The apparatus of Claim 25, wherein said first Z-direction means comprises a first stationary stage with a first lead screw arranged in said direction parallel to said Z-axis, a first drive motor for rotating said first lead screw and a first nut rigidly connected to said first X-direction means; said first X-direction means comprises a second stage installed on first X-direction means and having a second lead screw arranged in said direction parallel to said X-axis and a second nut rigidly connected to said second stage.

27. The apparatus of Claim 26, wherein said second stage has first gripping means for extracting said sample plate carriers from said sample storage means, each of said sample plate carriers being provided with means for releasable engagement with said first gripping means so that said first gripping means can engage said means for releasable engagement and extract said sample plate carrier from said sample storage means.

28. The apparatus of Claim 27, wherein said means for releasable engagement comprise at least one slot having a profiled configuration and wherein said first gripping means comprise at least one projection having a configuration conforming to said profiles configuration made so that said at least one projection can be introduced into and released from said slot by moving said first gripper only in said direction parallel to said Z-axis.

29. The apparatus of Claim 28, wherein said combined sample plate handling unit comprises:

second gripping means for taking said sample plates from said stand-by position, for transporting said sample plates in said direction parallel to said Y-axis from said stand-by position to said center of said ion-sampling orifice, and for holding said sample plates in said combined sample plate handling unit during said introduction of samples into said mass spectrometer through said ion-sampling orifice;

second X-direction means moveable in the direction parallel to said X-axis; and

second Y-direction means moveable in the direction parallel to said Y-axis.

30. The apparatus of Claim 29, wherein said second gripping means is an electromagnet, which can be energized for gripping said sample plates and de-energized for releasing said sample plates.

31. The apparatus of Claim 26, wherein said second Z-direction means comprises a second stationary stage with a third lead screw arranged in said direction parallel to said Z-axis, a third drive motor for rotating said third lead screw and a third nut rigidly connected to said first Y-direction means; said first Y-direction means comprising a third stage installed on said second Z-direction means and having a fourth lead screw arranged in said direction parallel to said Y-axis and a fourth nut rigidly connected to said third stage.

32. The apparatus of Claim 31, wherein said third stage rigidly supports said combined sample plate handling unit that comprises:

second gripping means for taking said sample plates from said stand-by position, for transporting said sample plates in said direction parallel to said Y-axis from said stand-by position to said center of said ion-sampling orifice, and for holding said sample plates in said combined sample plate handling unit during said introduction of samples into said mass spectrometer through said ion-sampling orifice;

second X-direction means moveable in the direction parallel to said X-axis; and

second Y-direction means moveable in the direction parallel to said Y-axis.

33. The apparatus of Claim 32, wherein said second gripping means is an electromagnet, which can be energized for gripping said sample plates and de-energized for releasing said sample plates.

34. The apparatus of Claim 14, further provided with a control system that comprises a central processing units loaded with input data for controlling motions and sequence of motions performed by said sample plate carrier handling mechanism for extracting said sample plate carriers from said sample storage means and for transferring them to said stand-by position and by said combined gripper and sample plate handling unit.

35. The apparatus of Claim 15, further provided with a control system that comprises a central processing units loaded with input data for controlling motions and sequence of motions performed by said first Z-direction means and said first X-direction means, as well as by said second Z-direction means and said first Y-direction means.

36. The apparatus of Claim 26, further provided with a control system that comprises a central processing units loaded with input data for controlling motions and sequence of motions performed by said sample plate carrier handling mechanism for extracting said sample plates from said sample storage means and for transferring them to said stand-by position and by said combined gripper and sample plate handling unit.

37. A method for sample analysis of samples on sample plates by atmospheric pressure ionization matrix assisted laser desorption ionization mass spectrometry comprising the steps of:

providing at least one sample plate carrier for carrying at least one of said sample plates;

providing a mass spectrometer having a vacuum chamber and an ion-sampling orifice for introduction of samples in the form of ionized products of laser desorption of said samples on said sample plates into said vacuum chamber of said mass spectrometer;

providing sample carrier storage means for storing said at least one sample plate carrier with said at least one sample plate;

providing a combined gripper and sample plate handling unit; and

using said combined gripper and sample plate handling unit for loading/unloading said sample plates into and from said at least one sample plate carrier and for docked interface with said ion-sampling orifice and for holding said sample plates during introduction of said ionized products of laser desorption of said samples into said mass spectrometer.

38. The method of Claim 37, further comprising the step of inserting said at least one of said sample plates into said at least one sample plate carrier prior to loading into said sample carrier storage means.

39. The method of Claim 38, wherein said step of inserting is carried out in a location remote from said mass spectrometer.

40. The method of Claim 38, wherein said sample plate carriers are used in a plurality and wherein each of said sample plate carriers carries one of said sample plates.